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ORIGINAL ARTICLE

The effects of a bioresponse system on the joint attention behaviour of adults with visual and severe or profound intellectual disabilities and their affective mutuality with their caregivers

Kyra Frederiks[1,2] | Paula Sterkenburg[2,3] | Emilia Barakova[1] | Loe Feijs[1]

[1]Industrial Design Department, Eindhoven University of Technology, Eindhoven, The Netherlands

[2]Clinical Child and Family Studies Department, Amsterdam Public Health Research Institute, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

[3]Bartiméus, Doorn, The Netherlands

Correspondence
Kyra Frederiks, Industrial Design Department, Eindhoven University of Technology, Eindhoven, The Netherlands.
Email: k.frederiks@tue.nl

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Abstract

Background: The subtle communicative behaviour of individuals with visual and severe/profound intellectual disabilities hinders the success of their interaction with professional caregivers. The bioresponse system, a tool to raise caregivers' awareness of the client's communicative behaviour, may improve the client's joint attention behaviour and the dyad's affective mutuality.

Method: Four client–caregiver dyads participated in a randomized multiple baseline study with repeated baseline, intervention and follow-up observations. The bioresponse system's effect was evaluated with measures of joint attention and affective mutuality.

Results: Two clients showed a significant difference on one or two joint attention subscales (including one significant decrease), and for all clients, at least one joint attention subscale revealed a positive trend. Positive trends in affective mutuality scores were observed in two dyads.

Conclusions: The results stress the importance of further research to the effects of using the bioresponse system's in daily care for persons with severe/profound intellectual disabilities.

KEYWORDS

affective mutuality, bioresponse system, effect study, joint attention, severe/profound intellectual disabilities, visual impairments

1 | INTRODUCTION

The quality of interaction considerably contributes to the quality of life for individuals with severe or profound intellectual disabilities (S/PID; Forster & Iacono, 2014). High-quality social interactions add to the happiness, social connectedness, independence and alertness of these individuals (Hostyn & Maes, 2009). However, the success of their interaction is often hindered due to their communication being mostly non-verbal with an idiosyncratic nature and limited symbolism. This subtle communicative behaviour can be challenging for others to detect and interpret (Griffiths & Smith, 2016).

Severe or profound intellectual disabilities are conjoined with a high prevalence of visual impairments (Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001). A lack of eye contact and gaze following hinders both interaction partners in noticing whether they hold each other's attention. Attuning between interaction partners is complicated, when visual impairments occur, due to less distinct emotional expressions and absence of reciprocal emotional responses (van den Broek et al., 2017).

Although subtle communicative behaviour and visual impairments may inhibit the expression of emotions, the autonomic nervous system (ANS) is activated as a result of (emotional) arousal. This activation can be captured through monitoring biological signals, like heart rate (HR), skin conductance (SC), skin temperature (ST) and respiration (RSP; Mokhayeri, Akbarzadeh-T, & Toosizadeh, 2011).

Kobayashi, Nunokawa, and Ooe (2009) measured this ANS activation using HR to support the interaction between caregivers and individuals with a severe motor and intellectual disability. They presented HR responses (e.g., acceleration, deceleration, no response or error) to create insight into the individual's behavioural response. Lima, Silva, Amaral, Magalhães, and de Sousa (2013) used HR to observe the responsiveness to stimuli of a child with profound intellectual and multiple disabilities. They were able to detect more responses to stimuli in the HR signal than they could observe in the child's motoric behaviour. Vos and colleagues measured emotional arousal with HR, HRV, SC, ST and RSP, and validated that observations of emotional behaviours from adults with S/PID are reflected in their HR, ST and RSP (Vos et al., 2012; Vos, De Cock, Petry, Van Den Noortgate, & Maes, 2013).

Research involving these biological signals is typically conducted in laboratory environments; however, measuring these signals in the field holds the opportunity to understand social processes in real life (Frederiks et al., in press). Although all studies described above have been conducted in the participants' homes, the nature of their study required approximating laboratory conditions through removing as many non-targeted stimuli as possible. Since acceptance of new technology depends on its adaption to the user's needs (Light & McNaughton, 2013), we argue that the technology needs to apply to daily care and socialization situations, in which a stimuli-free environment is not feasible. To address this need, we developed a bioresponse system, which measures emotional arousal through skin conductance and aims to improve joint attention behaviours in adults with a visual and severe or profound intellectual disability and the affective mutuality with their caregivers in daily practice. This system does not measure an (emotional) response to a specific stimulus but monitors the client's general (emotional) arousal. The system invites caregivers to observe the client's behaviour more carefully by displaying changes in the general arousal level, resulting in a better understanding of this behaviour. In a previous study, an early version of the bioresponse system was used with parents and their child with Prader–Willi syndrome (aged 8–30 months) to validate if the system can distinguish between positive and negative emotions when used in the home environment (Frederiks, Croes, Chen, Bambang Oetomo, & Sterkenburg, 2015). Since this distinction could not be made, the current version of the system was designed to monitor the client's general (emotional) arousal level, instead of emotions to specific stimuli or distinguishing between positive and negative emotions.

In the current study, the effect of the bioresponse system on the quality of interaction is determined through measures of joint attention and affective mutuality. The effect of the system on the caregiver's sensitivity and responsiveness is reported in (Frederiks, Sterkenburg, Barakova, & Feijs, in preparation). Intellectual and multiple disabilities exclude the use of self-assessment measures to validate the effects on the dyad's interaction, which is why we chose to evaluate the quality of interaction using indirect measures of joint attention and affective mutuality. We hypothesized that the use of the bioresponse system would result in increased frequency and/or duration of joint attention behaviours and elevated affective mutuality scores.

2 | METHOD

2.1 | Study design

A randomized multiple baseline design was used to study the effects of a bioresponse system on the client's joint attention behaviours and the dyad's affective mutuality. This study consisted of three phases: (a) a baseline phase (duration: 14–31 days), (b) an intervention phase (duration: 12 weeks) and (c) a follow-up phase (duration: 2 weeks). The intervention phase was preceded by a short training session on the use of the bioresponse system and followed by a 3-week break to prevent that the follow-up measurements were influenced by the effects from the intervention phase.

The varying baseline lengths were determined according to the method of Bulté and Onghena (2009). The participants were randomly assigned to three groups with each a different starting point for the intervention phase (Table 1). An independent researcher from the Vrije Universiteit Amsterdam determined the starting points and assigned them to the groups, using a drawing procedure. The requirements for the drawing were as follows: (a) one group had to start on day 1; (b) an interval of at least 4 days separated two starting points; (c) the baseline phase had to end on day 31; and (d) the baseline phase had to last for at least 14 days. To ensure that every participant could function as his/her own control person, video recordings and

TABLE 1 Randomized multiple baseline design with varying baseline lengths. The phases of the study are indicated per week

Clients	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Client A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	B				C	C	
Client B	A	A	B	B	B	B	B	B	B	B	B	B	B	B				C	C		
Client C	A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	B				C	C
Client D	A	A	B	B	B	B	B	B	B	B	B	B	B	B				C	C		

Note. A = Baseline phase; B = Intervention phase; C = Follow-up phase.

physiological signal measurements were recorded seven times in each phase, following the method of Kratochwill and Levin (2010).

2.2 | Participants

Four client–caregiver dyads from two Dutch organizations that provide support and care for people with visual and/or intellectual disabilities, Bartiméus (n = 2) and Royal Dutch Visio (n = 2), completed their participation in this study. These dyads were randomly selected from a list of 12 client–caregiver dyads. Developmental psychologists of both organizations selected these twelve dyads for participation based on the client meeting the following inclusion criteria:

- Clients are 18 years or older.
- Clients have a severe or profound intellectual disability, as defined in their personal files.
- Clients have a visual disability as defined in the World Health Organization standards (World Health Organization, 1980).
- Clients are able to participate during the complete period required for this study.
- Clients are able to remain seated for the duration of the video recording and physiological signal measurement.

The characteristics of the participating dyads are presented in Table 2. The caregivers and the client's legal representatives provided written consent for participation. The Medical Ethical Committee of the Vrije Universiteit Medical Center, Amsterdam, the Netherlands, approved this study (reference number: NL53963.029.15). The developmental psychologists employed at the two participating organizations provided the researchers with the demographic information including the level of intellectual disability found in the client's personal files.

Although eight client–caregiver dyads started participation, only four dyads completed the study. One reason for ending the participation in this study was that the tasks for the video recordings were not conformed the caregiver's expectations, as she felt the tasks did not live up to her promise to her client of having a fun time together during this study. For one client, the participation ended due to a mismatch of the tasks with the client's attention span and interests. The participation of two other clients was ended after they showed resistance to the sensor used in this study. The four remaining dyads on the list were not able to participate due to time limitations or were excluded because another dyad from the same group home was already participating in the study.

2.3 | Intervention

The bioresponse system is a tool to provide caregivers with additional cues to the client's communicative behaviour and to enhance the caregiver's understanding of this behaviour. This enhanced understanding allows the caregiver to better match his/her responses to the client's communicative signals and thereby might improve the affective mutuality between client and caregiver and stimulate the client's use of joint attention behaviour.

The system monitors skin conductance (SC) through a Shimmer 2R BioPhysical sensor (Shimmer, Dublin, Ireland) attached to a sock with integrated fabric electrodes (Figure 1). A tailor-made Android application developed by M. Croes, L. Vork and P. Peters (Eindhoven University of Technology) receives the SC signal via Bluetooth. This application, running on a tablet PC, visualizes this signal in the shape of a flower. Increasing/decreasing general arousal levels result in an increase/decrease in the SC signal. These alterations are displayed in the flower through corresponding changes in the flower's size (Figure 2a). The client's responses to stimuli in the environment, such as hearing one's name or music in the background, are shown in the SC signal as small peaks. An increasing number of peaks detected in the signal is visualized within the application through the appearance of additional (orange) flower petals (Figure 2b).

The bioresponse system was used in all observations made in this study; however, the application only provided visual feedback (the flower) during the intervention phase. During the baseline and follow-up phases, the application showed a blank screen, although the SC signal was still recorded in the background. In contrast to the baseline and follow-up phases, in the intervention phase the bioresponse system was not only used during the observations but also during daily care moments of the caregiver's selection. That is, caregivers were encouraged to use the system for 90 minutes during each shift they worked with the participating client during the intervention phase.

2.4 | Procedures

During each video and physiological signal recording, the client and caregiver were requested to perform two activities: a play moment and the Three Boxes procedure (NICHD Early Child Care Research

TABLE 2 Participant's demographic information

Client	Age	Gender	Intellectual disability	Developmental age (months)	Visual disability	Caregiver	Gender	CE[a]	CEC[b]
A	45	Male	Severe	25–36	Blind	A	Female	>5	>5
B	35	Female	Profound	8–10	Partial sight	B	Female	>5	>5
C	29	Female	Profound	2–4	Partial sight	C	Female	>5	>5
D	39	Female	Profound	11–13	Blind	D	Male	>5	1–2

[a]CE = Caregiver's Experience of working with the target group in years. [b]CEC = Caregiver's Experience of working with the participating client in years.

Network, 1999, 2003). The first task, the play moment, was designed to elicit joint attention behaviours, taking inspiration from the Early Social Communication Scale tasks (Mundy et al., 2003). It was a structured play task with a duration of 10 min that required the caregiver to present three toys (each for 2–3 min) followed by singing songs for/with the client for approximately 2–3 min. Each toy had an audible or tangible interaction that could trigger the client's attention and be operated either individually or through collaboration between caregiver and client, for example a soft book, a hat or a wobbly toy with sounds. Over the course of the study, two clients lost interest in the toys provided by the researchers; therefore, some of the client's own toys were included.

The Three Boxes procedure, initially intended for parent–child dyads, presents the dyad with three boxes each containing a different kind of toy. The parent is instructed to guide the child through 15 min of play, starting with box 1 and finishing with box 3. The parent can divide the time over the three boxes as he/she deems fit. For this study, the materials were slightly adapted to the abilities of the participating clients, and the boxes were replaced with bags for convenience of transportation. The first bag contained a tactile reading book. For one client, the tactile reading book was replaced by a storybook familiar to the client, due to the client having an aversion to touching objects. The second bag contained a pop-up puppet. Three clients did not show an interest in touching the puppet or in listening to the puppet's sounds; therefore, the pop-up puppet was replaced by a musical instrument. The third bag contained a cuddly toy that could make three different sounds.

FIGURE 1 Sensor sock and Shimmer 2R BioPhysical module [Colour figure can be viewed at wileyonlinelibrary.com]

2.5 | Instruments

2.5.1 | Joint attention

A self-developed observation manual, specifically designed for the observation of adults with visual and severe or profound intellectual disabilities, was used to measure joint attention during the play moment (see Appendix for the coding manual). This manual—based on the joint attention scale for blind infants (Bigelow, 2003), the joint attention scale for toddlers with autism (Naber et al., 2007) and the joint attention behaviours in people with profound intellectual and multiple disabilities (Neerinckx & Maes, 2016)—contains three scales (preliminary behaviours [PB], basic joint attention behaviours [BJA] and associated joint attention behaviours [AJA]). The PB scale has three subscales: "find objects," "gestures towards objects" and "gestures requesting interaction." The BJA scale consisted of the subscales "pointing" and "focusing attention." The AJA scale has six subscales: "follow direction," "show object," "checking," "labels," "take" and "give." For each subscale, the occurrence and duration of the behaviour are scored.

Five independent observers, bachelor's students in Developmental Psychology at the Vrije Universiteit Amsterdam, scored the video recordings blind to the phase of the study and in random order using Noldus The Observer version 10.5 software

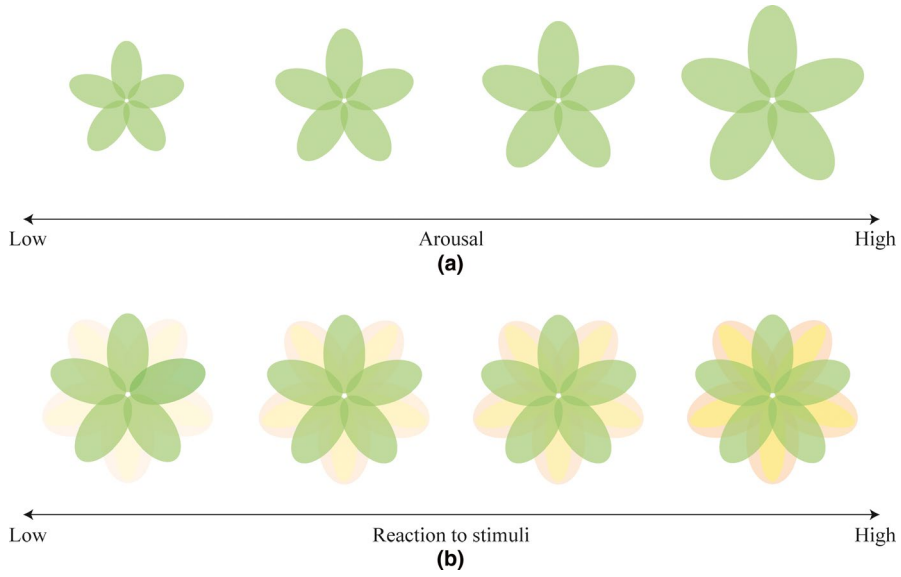

FIGURE 2 The flower representation of the skin conductance signal [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Friedman's ANOVA test and meta-analysis (four clients combined) results of comparing the baseline, intervention and follow-up phase

		Client A		Client B		Client C		Client D		Combined	
Scale		Frequency	Duration	Frequency	Duration	Frequency	Duration	Frequency	Duration	Frequency	Duration
Preliminary behaviours	χ^2	2.0	2.57	5.04	6.0	0.92	3.71	1.14	2.57	9.12	14.88
	df	2	2	2	2	2	2	2	2	8	8
	p	0.37	0.28	0.08	0.05	0.63	0.16	0.57	0.28	>0.25	<0.10
Basic joint attention	χ^2	0.67	0.0	6.0	1.14	0.52	1.14	2.92	2.92	10.1	5.2
	df	2	2	2	2	2	2	2	2	8	8
	p	0.72	1	0.05	0.57	0.77	0.57	0.23	0.23	>0.25	>0.25
Associated joint attention	χ^2	1.14	11.14	3.08	0.8	0.13	2.71	4.08	0	8.42	12,74
	df	2	2	2	2	2	2	2	2	8	8
	p	0.57	0.004	0.21	0.67	0.94	0.26	0.13	1	>0.25	<0.25
Scale		**Client A**		**Client B**		**Client C**		**Client D**		**Combined**	
Affective mutuality	χ^2	0.52		0.07		3.00		2.39		5.97	
	df	2		2		2		2		8	
	p	0.77		0.96		0.22		0.30		>0.25	

(Noldus Information Technology, Wageningen, the Netherlands). After a short training on three videos, all videos were scored by two observers, who coded independently of each other, and the resulting scores were averaged for use in the analyses. The percentage of agreement on the frequency of PB, BJA and AJA behaviours were 64.3%, 47.7% and 55.3%, respectively, and 96.3% (PB), 89.7% (BJA) and 96.7% (AJA) for the duration of these behaviours. Cohen's kappa was for the frequency 0.49 (PB), 0.17 (BJA) and 0.50 (AJA) and 0.95, 0.82 and 0.96, respectively, for the duration.

2.5.2 | Affective mutuality

Affective mutuality was measured with the dyadic scale of the 24-month version of the National Institute of Child Health and Human Development (NICHD) scales, rated on a 7-point Likert scale (Brady-Smith, O'Brien, Berlin, Ware, & Brooks-Gunn, 1999). The dyadic scale has one subscale, "mutuality/connectedness," that measures the synchrony, comfort and mutual pleasure in the dyad's interaction.

Four independent observers, master's students in Developmental Psychology at the Vrije Universiteit Amsterdam, coded the video recordings of the Three Boxes procedure blind to the phase of the study and in random order. Prof. C. Schuengel, a registered NICHD trainer, Dr M. Oosterman and Dr P.S. Sterkenburg from the Vrije Universiteit Amsterdam provided training for the independent observers. Each video was scored by two observers. Consensus was reached between two observers when the difference between the observers' scores was two points or more. For scores with less than two points difference, the average scores were used for analyses purposes. In a similar study by Sterkenburg and Schuengel (2010), the intraclass correlation (ICC) for the observers for the dyadic scale was 0.94 with no observer drift. In the current study, the ICC for the dyadic scale was 0.92.

2.6 | Analysis

The analysis procedure, consisting of two parts, was used for the three joint attention categories separately (PB, BJA and AJA) as well as for the affective mutuality scores. Only observational data were used; the physiological data were only used as feedback for the caregivers during the intervention. The first part of the analysis was to visually inspect the trend in both the frequency and the duration of the behaviours.

For each individual client, the regression line and the regression coefficient (RC) were calculated and the regression line plotted together with the scores of the 21 observations of PB, BJA, AJA and affective mutuality. The trend was categorized as positive for an increasing regression line and positive RC, or as negative for a decreasing regression line and negative RC. The degree of positivity/negativity of the trend was classified as slight ($-0.5 > RC < 0.5$), moderate ($0.5 < RC < 5$ or $-5 > RC > -0.5$) or steep ($RC > 5$ or $RC < -5$).

The second part consisted of performing a Friedman's ANOVA test to control for a significant difference ($\alpha = 0.05$) between the baseline, intervention and follow-up phases. The analyses are performed for each participant separately. As each phase existed of seven repeated observations, a repeated measure design was used. The non-parametric analysis, the Friedman's ANOVA, was selected over the parametric analysis, the repeated measures ANOVA, because with only seven repeated measurements per dyad a repeated measures ANOVA is not reliably.

After performing the Friedman's ANOVA test for each dyad separately, the results of the four participating dyads were combined in a meta-analysis, in which the natural logarithms of the *p*-value for

TABLE 4 Average frequency and duration of joint attention and affective mutuality behaviours per phase

		Baseline		Intervention		Follow-up	
		Frequency	Duration	Frequency	Duration	Frequency	Duration
Scale	Client	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Preliminary behaviours	Client A	2.86 (1.46)	356.19 (188.52)	3.79 (1.87)	401.75 (314.43)	4.21 (1.25)	512.14 (136.99)
	Client B	5.64 (1.86)	119.80 (83.87)	3.29 (2.84)	69.04 (121.82)	3.43 (2.64)	42.06 (40.52)
	Client C	6.07 (5.62)	60.20 (60.63)	8.43 (1.52)	175.07 (102.58)	6.86 (5.27)	110.68 (95.15)
	Client D	3.64 (2.39)	12.45 (7.37)	6.43 (7.17)	9.67 (8.81)	11.50 (7.81)	24.55 (14.82)
Basic joint attention	Client A	3.46 (2.48)	185.63 (175.16)	3.21 (2.46)	120.38 (106.52)	4.43 (3.06)	124.37 (89.35)
	Client B	6.64 (2.69)	110.37 (141.75)	3.86 (2.25)	41.48 (36.37)	6.43 (4.67)	80.95 (61.22)
	Client C	10.64 (9.06)	84.95 (64.38)	8.21 (2.80)	106.47 (45.23)	11.36 (7.14)	100.53 (70.13)
	Client D	0.29 (0.57)	0.90 (1.63)	0.00 (0.00)	0.00 (0.00)	0.71 (1.47)	3.15 (8.14)
Associated joint attention	Client A	15.64 (8.54)	160.32 (96.71)	18.36 (9.56)	217.78 (146.15)	19.29 (4.44)	388.47 (106.85)
	Client B	1.64 (1.68)	5.20 (13.75)	0.43 (0.45)	2.75 (6.28)	0.50 (0.65)	6.93 (18.32)
	Client C	1.36 (1.57)	6.98 (9.60)	1.29 (1.63)	2.65 (4.74)	1.36 (2.32)	7.71 (19.99)
	Client D	1.29 (0.81)	4.69 (11.82)	0.43 (0.79)	1.12 (2.42)	2.93 (3.62)	3.65 (6.40)
		Mean (*SD*)		Mean (*SD*)		Mean (*SD*)	
Affective mutuality	Client A	5.17 (0.47)		4.68 (0.67)		4.32 (1.28)	
	Client B	2.89 (1.19)		3.61 (1.32)		3.25 (1.70)	
	Client C	2.00 (0.71)		3.04 (1.08)		2.43 (1.46)	
	Client D	2.78 (1.17)		2.58 (1.34)		1.75 (0.60)	

each client were summed and multiplied by −2. *p*-Values smaller than 0.005 were replaced with the value of 0.01, and changes in unexpected directions were replaced with the value 0.5 regardless of the actual value. The outcome followed a chi-square distribution with the number of cases multiplied by two as degrees of freedom (De Weerth & Van Geert, 2002).

3 | RESULTS

3.1 | Joint attention

Due to technical problems with the video files, two videos from Client A proved unusable for analyses and are therefore excluded. The Friedman's ANOVA test showed a significant difference for the frequency of BJA behaviours of Client B ($\chi^2 = 6.0$, $p = 0.05$) and the duration of AJA behaviours of Client A ($\chi^2 = 11.14$, $p = 0.004$). The decreasing trend in the duration of PB behaviours of Client B ($\chi^2 = 6.0$, $p = 0.05$) was also significant. No significant differences were found for Clients C and D (Table 3). Since Client A's *p*-value for the duration of AJA was lower than 0.005, this value was replaced by 0.01 in the meta-analysis. No replacements for unexpected directions were made, due to the Friedman's ANOVA test following a chi-sqaure distribution (which only provides a right-tailed test). The result from four clients combined was not significant.

The mean frequency of the observations per phase showed a substantial increase in PB behaviours for Client D (Table 4). Client C's mean frequency for BJA behaviours was lower in the intervention phase compared to the baseline and follow-up phases, while the mean duration for the intervention phase was higher than for the baseline and follow-up phases. Due to the moderate interrater agreement on the frequency of PB and AJA and the slight interrater agreement on the frequency of BJA behaviours, these results need to be interpreted with caution. The mean duration of PB behaviours for Clients A and C increased substantially in the intervention phase compared to the baseline phase. For Client A, this trend continued in the follow-up phase, while for Client C the mean duration decreased in the follow-up phase. Visual inspection of the joint attention behaviours of Client A showed a steep incline in the duration of PB and AJA behaviours with a regression coefficient (RC) of 13.43 and 13.02, respectively, and a decline in BJA behaviours with an RC of −5.29. This trend was also reflected in the frequencies, although less pronounced (Figure 3). Client B's BJA behaviours increased in frequency (RC: 0.05), however, decreased in duration (RC: −1.18); while her AJA behaviours decreased in frequency (RC: −0.06) and increased in duration (RC: 0.35; Figure 3). Client C had a moderate increase in duration of PB and BJA behaviours (RC of 3.7 and 0.84, respectively) with only a slight increase in frequency (PB: 0.13 and BJA: 0.09; Figure 3). Client D showed a moderate increasing trend for both frequency and duration in PB behaviours (RC of 0.68 and 0.88, respectively), but only a slight increase in BJA (RC frequency: 0.04 and RC duration: 0.2) and AJA behaviours (RC frequency: 0.15 and RC duration: 0.01; Figure 3).

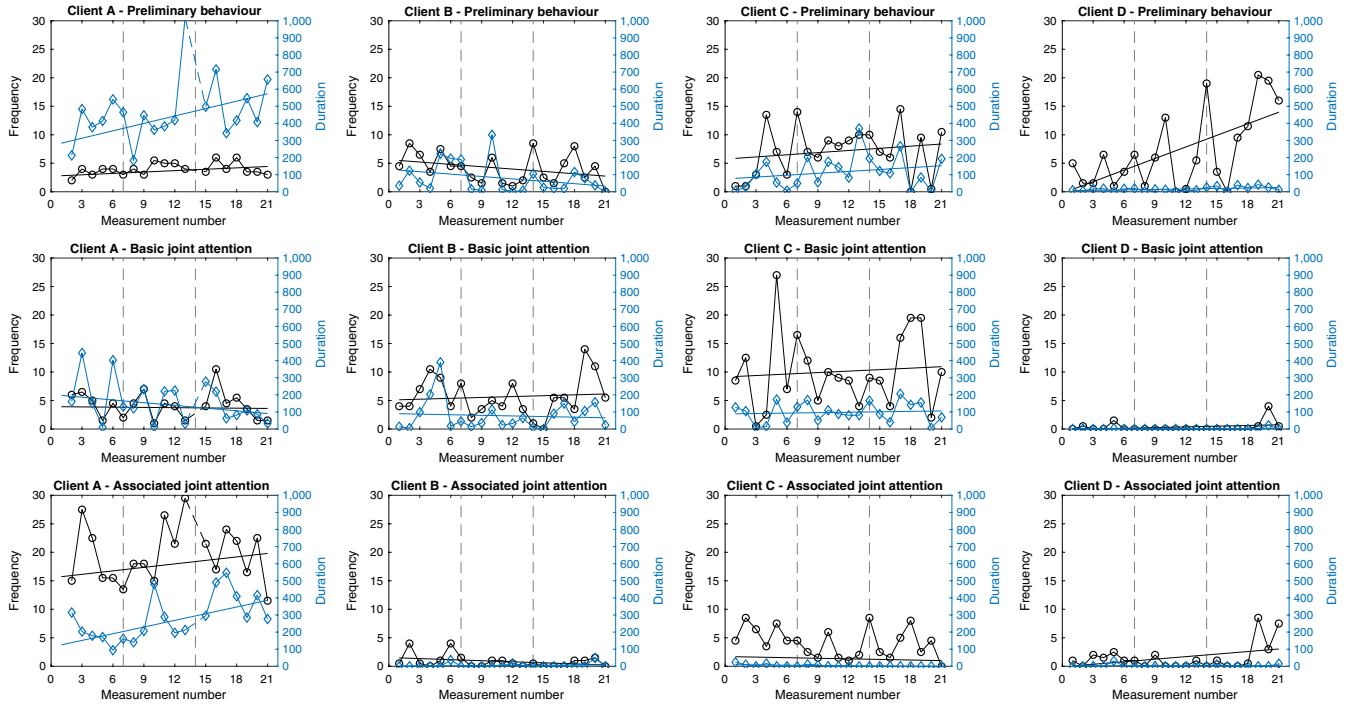

FIGURE 3 Frequency (black) and duration (grey) of preliminary behaviours (top), basic joint attention behaviours (middle) and associated joint attention behaviours (bottom) [Colour figure can be viewed at wileyonlinelibrary.com]

3.2 | Affective mutuality

One video from Dyad D is excluded from analyses as a result of failing recording equipment. The Friedman's ANOVA test and the meta-analysis results showed no significant differences in affective mutuality scores for the baseline, intervention and follow-up phases (Table 3). For Clients B and C, the mean affective mutuality scores indicated a higher score for the intervention phase compared to the baseline and follow-up phases. The mean scores decreased from the baseline to the follow-up phase for Clients A and D (Table 4).

The visual inspection of the affective mutuality scores showed a positive trend for Dyad B during the intervention and follow-up phases (RC of 0.10 and 0.31, respectively; Figure 4b). Dyad C's affective mutuality scores increased during baseline and intervention phases (RC of 0.29 and 0.06, respectively), however, decreased in the follow-up phase (Figure 4c). The scores of Dyad A displayed a positive trend for the baseline phase (RC: 0.18), however a decreasing trend during the intervention (RC: −0.10) and follow-up phase (RC: −0.06; Figure 4a). Dyad D showed a negative trend for baseline and intervention phases (RC of −0.30 and −0.05, respectively), but an increasing trend for the follow-up phase (RC: 0.10; Figure 4d).

4 | DISCUSSION

The results from this randomized multiple baseline study suggest that the bioresponse system could improve the client's joint attention behaviour and the dyad's affective mutuality between caregivers and adults with S/PID. Two out of four clients showed a significant increase on one of the three joint attention subscales. For all clients, a positive trend was visible for at least one joint attention subscale. However, none of the clients showed a positive trend on all three subscales neither did one subscale improve for all four clients. Due to the interrater agreement on the frequency being slight for BJA behaviours and moderate for PB and AJA behaviours, while the interrater agreement on the duration was almost perfect for all behaviours, it is likely that the duration scores better reflect the effects of the bioresponse system on the joint attention scores than the frequency scores. Considering the duration behaviours only, just one client showed a significant increase on a subscale of joint attention and one client showed a significant decrease. Looking at the mean durations, for every subscale one client had a higher mean duration during the intervention phase than during the baseline phase, and two clients had a higher mean duration during the follow-up phase than during the intervention phase. Visual inspection of the data shows an increasing trend over all phases for two clients on PB behaviours and for one client for AJA behaviours.

The affective mutuality scores revealed no significant differences, but in the visual inspection of these scores a positive trend for two client–caregiver dyads was visible during the intervention phase. A slightly negative trend was present for the other two dyads. For one of the two dyads with a positive trend in the intervention and one of the two dyads with a negative trend in the intervention, the trend in the follow-up phase was positive. The other two dyads showed a slightly negative trend in the follow-up phase.

The negative trend in affective mutuality for Dyads A and D might be explained due to the intervention co-occurring with the summer holiday season. Although Caregiver A did not take leave

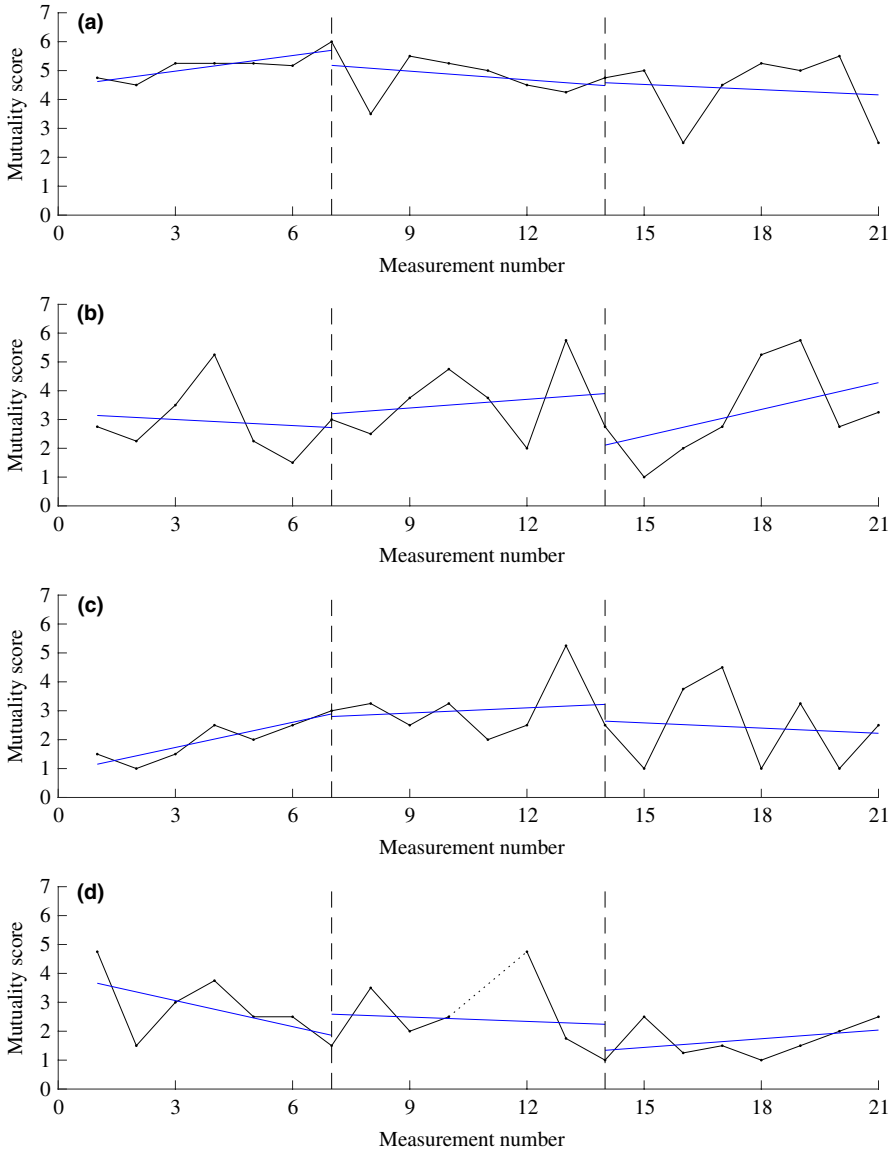

FIGURE 4 Regression lines for affective mutuality scores [Colour figure can be viewed at wileyonlinelibrary.com]

during the intervention phase, she reported Client A being insecure and displaying more challenging behaviour due to the quick changes in staff and absence of many regular caregivers. The 4-week leave of Caregiver D in the middle of the intervention phase might have provided this caregiver with fewer opportunities to use the bioresponse system. The increasing trend in the follow-up phase might suggest that the bioresponse system did have a positive influence on dyad D's affective mutuality. The decreasing affective mutuality scores in the follow-up phase for Dyad C might be explained by the relocation of client and caregiver to different group homes just before the sixth intervention observation, which resulted in the dyad's opportunities for interaction being limited to the study's observations.

The observed effects of the bioresponse system in this study were not substantial, nevertheless important. The participants' age might have influenced the strength of the results. The measures to evaluate the effects were conducted with adult participants, while the joint attention scales were inspired on measures specifically developed for children, and the NICHD scales are specifically developed for children. In comparison with children, adults have a more gradual curve of development. Given the short intervention period (12 weeks), the observed improvements in joint attention behaviours suggest the potential positive effect the bioresponse system can have on the quality of interaction.

4.1 | Limitations

As the current study involved a small sample (n = 4), results cannot be generalized. However, the effects are observed over a period of 5 months in repeated measures, which suggest these effects are consistent and likely to be found in other clients with visual and severe or profound intellectual disabilities as well. Due to the study period of 5 months and the 3-week break between intervention and follow-up phases, this study can only reveal short-term effects. Long-term research involving a larger sample is required for solid conclusions on the effect of a bioresponse system on the interaction quality. Future research may also include a validation of the

measures used in this study by comparing the observed scores with physiological measures.

As the participating clients attended a daytime activity programme, the caregivers mainly provide daily care; therefore, the play tasks were an uncommon interaction for both the caregiver and client. The uncharacteristic interaction may have influenced the joint attention behaviours and the affective mutuality of the participating dyads. Since the dyads are only occasionally involved in these kinds of interactions and the interaction was repeated during each observation, the effects as a result of a diverging interaction are expected to be minimal.

Several caregivers indicated that the feedback from the flower reflected their observations of the client's behaviour, but did not provide additional information. As this was the first time, caregivers could use the bioresponse system in practice over a period of 3 months, and the settings of the flower application were not yet optimized. Although the sensor could measure the client's arousal levels and reactions to environmental stimuli with high precision, the flower did not display the measurements with equal precision. This lack of precision may have contributed to low significance of the results.

The interrater agreement on the frequency of the joint attention scales was slight for the BJA scale (0.17) and moderate for the PB (0.49) and AJA scale (0.50), while the agreement on the duration was an almost perfect agreement (PB: 0.95, BJA: 0.82, and AJA: 0.96; McHugh, 2012). This difference suggests that an episode of joint attention behaviour was differently interpreted by the observers as either a single occurrence or several occurrences of joint attention behaviour, while the total duration of this behaviour was scored equally. As the analysis was conducted with average scores, the expected influence of the disagreement between observers is expected to be minimal. However, for future uses of this joint attention scale, the frequency scoring of the joint attention behaviours should receive specific attention.

5 | CONCLUSION

Although the minority of the results yielded significance, the visual inspection of the data showed a positive trend in the quality of interaction due to the use of the bioresponse system. All clients showed a positive trend on at least one of the three subscales for joint attention behaviours, although the trends were not consistently positive on all three subscales for one client neither for all clients on one subscale. Two out of four client–caregiver dyads showed a positive trend for affective mutuality scores; the other two dyads displayed a negative trend. Long-term research with a larger sample is required for solid conclusions on the effect of a bioresponse system on the quality of interaction. However, this study has shown that the bioresponse system has potential to positively influence the quality of interaction between professional caregivers and adults with visual and severe or profound intellectual disabilities.

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ORCID

Kyra Frederiks https://orcid.org/0000-0003-1408-4076

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APPENDIX A

SCORING MANUAL: JOINT ATTENTION©

Developed for observation of adults with visual and severe or profound intellectual disabilities

Behaviours relevant to joint attention	
Preliminary behaviours	
Find objects	The client uses the caregiver's body to find objects, for example tactually scanning the caregiver's body to the hand that may hold an object
Gestures towards object	The client shows behaviour that may be interpreted as gestures concerning objects, for example discarding an object after fleeting contact or resists having an object taken away
Gestures requesting interaction	Gestures requesting interaction are gestures towards an object that can be interpreted as a request from the client for support from the caregiver to achieve an action or interaction with the object, for example clapping hands as a request to turn on the music
Basic joint attention (BJA)	
Pointing	The client points in the direction of the object (because of the visual impairment the client may point in the general direction of the object instead of directly to the object)

APPENDIX A (Continued)

Focusing attention	The client concentrates on the sounds of the object or the caregiver's voice (e.g., The client stops (un) controlled movements and looks upwards to be able to focus on the sound)
Associated joint attention (AJA)	
Follow direction	The client follows the sounds of the object or the caregiver's voice with head movements (e.g., moving the ear closer to the sound source)
Show object	The client shows the object to the caregiver, for example the client moves the caregiver's hand towards an object
Checking	The client consciously touches the caregiver's hand, arm or leg to check whether the caregiver is still present (reaching for the caregiver's hand, arm or leg is not sufficient for this score) or calls the caregiver's name
Labels	The client labels an object, an action or an intention through the use of words or signs (e.g., clapping hands to switch on the music)
Take	The client accepts an object from the caregiver (also when the client immediately throws the object away, accepting the object is sufficient for this score)
Give	The client offers an object to the caregiver. The client holds the object until the caregiver reaches for or takes the object from the client